

HOW IT WORKS

Image stabilisation

It's not always convenient to use a tripod with your camera, so image-stabilisation techniques are a must for modern cameras. Tom Royal explains how they do their valuable job

It's annoying when you take what you think will be a great photo, only to find out later that it's a blurry mess. More annoyingly still, this tends to happen most often when you're photographing a once-in-a-lifetime event. If you see something remarkable and rush to take a photograph, there's even more chance that you'll shake the camera, producing a blurry picture.

Similarly, the sharp pictures produced by modern digital camcorders can be marred by camera shake. You'll get far better results by mounting your video camera on a tripod, but this isn't always practical. A tripod might be easy to use when filming a wedding, but it's not as realistic when you're out and about.

Fortunately, many modern cameras, lenses and digital video cameras incorporate image-stabilising technology. These products all help you to get sharper photos and steadier video footage, and they have other advantages, too. When using a camera with image stabilisation, you're able to use longer exposure times when working without a tripod. This can help you take photos that would otherwise be impossible. You can use smaller apertures to capture a larger depth of field, and do low-light photography without a flash.

Almost all camera manufacturers have some kind of proprietary image-stabilisation system, but most rely on three common techniques.

Some stabilise the image using a moving lens, some use a moving image sensor and some use digital processing to correct a shaky image after it has been recorded.

LENS BE FRIENDS

If you have an SLR camera, you can easily upgrade to an image-stabilisation system by adding a stabilised lens. This is particularly handy, as SLR users are likely to encounter many situations where stabilisation would be useful.

As they use interchangeable lenses, SLRs are the ideal camera if you want to use a very long telephoto lens for wildlife photography. But as lenses get longer, two problems emerge. First, slight camera shake is greatly magnified because your subject is distant. Second, long telephoto lenses have relatively small apertures. This means that when you're shooting a subject that's very far away, you'll need to use a longer exposure, and this increases the risk of blur. For this reason, many long telephoto lenses include image stabilisation. Canon demarcates its stabilised lenses with the letters IS in the lens name, while Nikon uses the letters VR (for Vibration Reduction).

Image-stabilised SLR lenses require power, which they get from the SLR body itself. This isn't unusual, as most high-quality autofocus lenses contain an ultrasonic focusing motor that

also requires power from the camera body, and many use a motor in the lens to operate the aperture blades. Inside the body of the lens are two velocity sensors. One is mounted above the glass lens elements, and one is mounted to the side of them. The sensor above the elements detects pitching, or vertical movement, and the sensor to the side detects yawing, or horizontal movement. These sensors are connected to a small computer, which in turn is connected to two motors. These motors are attached to one of the glass elements that make up the lens. As with the sensors, one is mounted above the lens, to move it vertically, and one to the side, to move it horizontally.

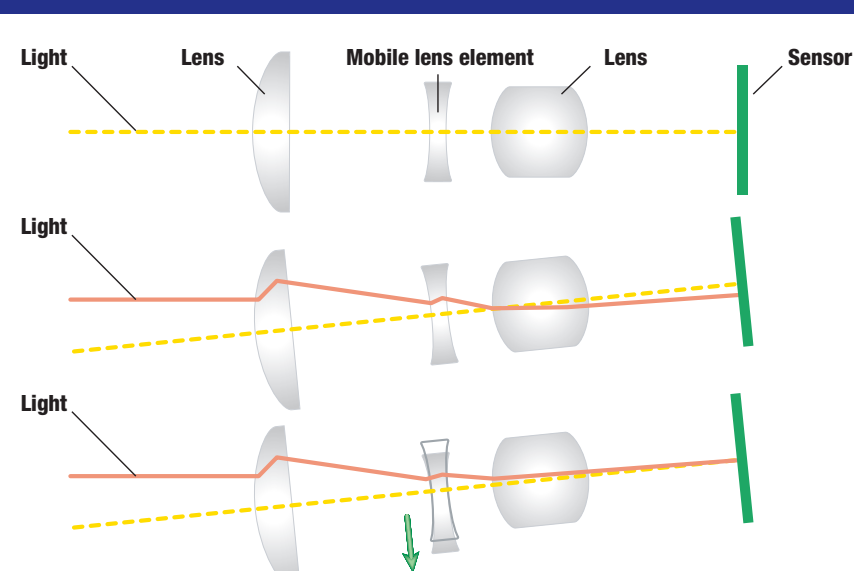
Blur in a photograph is caused when the camera, and so its lens, moves during the time that its shutter is open. With the camera mounted perfectly still on a tripod, rays of light from a fixed point in the scene being photographed will pass through the stationary lens of the camera and hit the sensor or film in one location only. If the camera is held in your hand, though, it might move between the shutter opening and closing again.

In this case, a ray of light from the subject entering the camera just as the shutter opens will hit the sensor in one location, and a ray of light from the subject entering the camera just before the shutter closes will hit the sensor in another location. The sensor will record that point in both locations and every point in between, smearing the image slightly. If the end of the camera lens is tilted slowly downwards, for example, light from the point will start to hit the sensor at one point, then move down the sensor as the lens is tipped.

An image-stabilised lens removes motion blur by altering the path of light through the camera lens. When you depress the shutter button, activating the camera's metering and autofocus systems, the image stabiliser starts working. The velocity sensors check for horizontal and vertical movement, and pass this to the lens computer. The computer sends power to the two motors attached to the moving lens element.

If the end of the camera's lens is tipping downwards, the pitching sensor will detect this. It sends this information to the computer, which instructs the motor above the mobile lens element to move that element down slightly. This corrects the path of the light so that even as the lens tips downwards, light from a fixed distant point will continue to hit the sensor in the same place. The system keeps monitoring for movement and adjusting the mobile lens element until the camera releases the aperture blades, indicating that the shutter has closed and the picture has been taken.

Good vibrations How stabilised lenses work



▲ If the camera lens is steady (top), light from a distant point hits only one part of the sensor. If the lens moves (middle), then light moves across the sensor, creating a blurry picture. On a stabilised lens (bottom), a lens element moves to counteract the shake, keeping the light focused on one point

The mobile lens element in a stabilised lens has a limited range of movement, so there is a limit to how much shake can be counteracted. Nikon's Nikkor VR lenses make the most of the mobile element's limited range by centring the element just as the shutter is triggered and while the SLR mirror is being pulled up out of the way. This ensures that the lens has plenty of room to move in any direction to correct motion during the exposure.

The principle of moving a lens element to correct camera shake may be relatively simple, but its implementation requires some clever technology. This is particularly so for systems that stabilise the image as you compose a shot. When composing a photo you're unlikely to keep the camera pointed in exactly the same direction. Instead, you'll probably want to make minor adjustments to its direction as you try to frame the image. This means that the image stabilisation system needs to discern whether any movement to the camera is a conscious decision on your part or hand shake that should be corrected. The computer inside the lens is programmed to detect steady panning motions, which are likely to be deliberate, and take no action to correct them.

MOVE YOUR BODY

Fitting image-stabilisation technology into a lens has obvious advantages. You're unlikely to own more than one long telephoto lens, and by fitting the stabilising system inside you can use it with several camera bodies, and even with both 35mm film and full-frame digital cameras. It also allows you to upgrade a relatively inexpensive camera body to image stabilisation at a later date. However, if you need to use many types of lens, and you want them all to be shake-free, you could in effect end up buying the same technology again and again with each lens that you purchase.

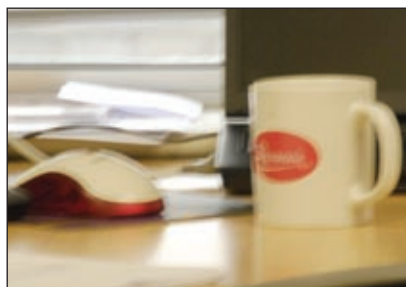
With this in mind, a number of camera manufacturers prefer to place image-stabilisation technology inside the body of the camera. Konika Minolta uses this technique in its Dynax 7D SLR. Sony's Alpha SLR range is based on Konika's Dynax models, and uses the same technology, branded as Super SteadyShot.

SLR cameras don't contain any lens elements in the camera body itself, so it's impossible to use the image-stabilisation technique used in stabilised lenses. Instead, cameras with built-in stabilisation move the CCD sensor as it records images. The CCD is mounted on a platform that can be moved in all four directions, and is adjusted to compensate for camera movement



▲ Stabilised lenses can be fitted to most SLR cameras. This AF-S Nikkor 18-200mm VR lens will stabilise shots from any Nikon DX DSLR

Long shot Telephoto image stabilisation in action



▲ These photos were taken using a 200mm AF-S Nikkor VR lens using f/13 and an exposure time of $\frac{1}{40}$ sec. The image stabiliser was disabled for the shot on the left and enabled for the one on the right

in the same way as the mobile lens element in a stabilised lens.

Moving the camera's CCD rather than a lens element has several advantages. Most importantly, it allows the technique to be used in cheaper non-SLR cameras. Most of Nikon's Coolpix compact cameras with vibration reduction use this method. It has advantages for SLR users, too. With the stabiliser built into the camera body, you can use it with almost any lens – Konika Minolta lists only one Macro lens as incompatible with its system. Sony has also made clever use of its SteadyShot system to help eliminate another problem for DSLR users. With the inside of the camera exposed every time you change lens, it's all too easy to get dust inside an SLR camera. If this gets on the CCD sensor it can ruin your photos, and CCDs require very delicate cleaning. When you start a Sony Alpha DSLR it rapidly vibrates the CCD in an effort to shake off any dust that might have settled there.

When used in a DSLR camera, this system of CCD-based stabilisation has one key disadvantage when compared to a mobile lens element. Although compact cameras allow you to compose a picture using the image taken from the CCD, DSLRs use an optical viewfinder. As this mechanism is completely separate from the CCD, the image you see when composing a picture cannot be stabilised.

CLEANED BY COMPUTER

Image-stabilisation techniques that involve moving the CCD or a lens element are usually referred to as optical image stabilisation, as they alter the position where light strikes the camera's sensor. An alternative stabilisation technique is more commonly used in digital video cameras. This requires no moving parts, and is referred to as digital video stabilisation.

Digital image stabilisation works on a principle very similar to an optically stabilised lens or camera. Rather than using a moving lens element or CCD platform to make sure rays of light from an object being filmed land on the same part of the CCD sensor, digital stabilisation allows the image to wander on the sensor then corrects this digitally after it has taken place. If the lens of the camera has been tipped down very slightly, for example, the image taken by the sensor might have moved downwards by one pixel. A processor inside the video camera analyses consecutive frames to see if this kind of motion is taking place, and adjusts the frames to correct it. If the second of two frames shows the image moving down by one pixel, for example, it simply shifts this image back upwards again by removing the top line of pixels.

The problem with this method is that the sensor has a limited size. By moving a frame up by one pixel, for example, you lose the top line of the image and introduce a new, blank line at the bottom. In order to get around this problem, video cameras with digital stabilisation often use a CCD with a slightly higher resolution than the image they produce. By having a border of spare pixels around the area normally used to record video, the stabiliser can correct a limited amount of movement in any direction.

Like the still cameras that stabilise their viewfinders, digital video stabilisation must attempt to discern between involuntary and intentional camera movement. Just as the processor in a camera or lens analyses consecutive movements to judge which are deliberate, a digitally stabilised video camera must analyse the video to determine which motions are the result of intentional pans and which are caused by hand shake.

You don't necessarily need a video camera with digital stabilisation to use this technique. If you have good video-editing software, the same method can be applied using a filter when editing your footage. As these filters don't have access to the extra pixels used by a camera with a built-in stabiliser, though, the resulting video will have to be cropped around the edges slightly to hide the effects of frames being shifted.

Finally, some cameras have a 'digital image stabilisation' mode. This sometimes has nothing to do with the technique we've just described. On some cameras the digital-stabilisation mode simply switches the camera to a high ISO sensitivity setting, so it can use shorter shutter speeds to reduce blur in low light. This technique isn't really image stabilisation, and it doesn't require any special hardware: you can manually choose a high ISO setting on any DSLR and most good compact digital cameras. The downside of using a high ISO setting is that noise in the image will be increased, making it unsuitable for large prints. ☐

FURTHER INFORMATION

Konika Minolta's mobile CCD stabilisation system
http://ca.konicaminolta.com/products/consumer/digital_camera/slr/dynax-7d/02.html

Nikon VR technology
www.nikon.co.jp/main/eng/portfolio/about/technology/nikon_technology/vr_e/index.htm